4. MEASUREMENT OF SMALLHOLDER TREE FARMS ON LEYTE ISLAND

Glenn Monterola, Florante Morales, John Herbohn, Jerome Vanclay, Grant Wardell-Johnson, Eduardo Mangaoang and Steve Harrison

This paper describes the field techniques used to measure timber volume and log quality from smallholder tree farms on Leyte Island conducted as part of ACIAR project *ASEM/2003/052, Improving Financial Returns from Smallholder Tree Farms in the Philippines*[1]*.* Tree farms were included in the sample if they were 0.1 ha or greater in area and contained 100 or more trees. Paired circular blocks were chosen for measurement, one in the centre and one on the edge of the tree block. Where tree farms included multiple blocks of trees, two circular plots were established within each block. For each tree over 10 cm diameter at breast height (dbh) in the plot, measurements were made of dbh, diameter at the base (db), tree height, location, crown depth, crown radius, bearing and distance of each tree with reference to the plot centre. Estimates of log lengths and grade that each tree was expected to yield were also recorded, along with a sketch of each tree. In addition, data were collected on tree farm, block and plot characteristics, and were entered into an ACCESS database for subsequent analysis.

INTRODUCTION

Tree measurement on smallholder tree farms has been one of the major activities of ACIAR project ASEM/2003/052, *Improving Financial Returns from Smallholder Tree Farms in the Philippines.* The project was designed to improve the livelihoods of smallholder tree farmers in Leyte Province through investigating ways to improve financial returns from forestry, and promote the adoption of these improved management methods (Herbohn and Harrison 2005; Herbohn *et al.* 2007). One of the project objectives has been to assist smallholder tree growers to satisfy timber market requirements and improve productivity. The preliminary step in helping tree farmers to access formal timber markets is to identify the market requirements in terms of species, type, quantity and quality of timber required by processors (Herbohn and Harrison 2005). When sufficient data are available, the construction of a yield table for an established plantation is a relatively easy matter (Vanclay and Baynes 2005). A yield table can be created by measuring the volume per plot on a range of plantings, and fitting the yield function using linear regression.

The objective to assist smallholder tree growers to satisfy market requirements and improve productivity was addressed partly through the assessment of timber quality (i.e. physical features, including straightness, forking, appearance of defects and knots) and timber volume of tree farms on Leyte Island. Constructing a yield table for a smallholder plantation in Leyte is challenging because there are few old plantations, and because the large range of sites (e.g. geology, topography, elevation) and stand conditions (spacing, thinning, fertilizing and pest control) means that yields may vary greatly from one smallholder plantation to another (Vanclay and Baynes 2005). Information gathered from tree farms is contributing to improve the knowledge on silvicultural requirements and tree farm systems

[1] This is a shortened version of a paper presented by the authors at the IUFRO 3.08 conference on *Improving the Triple Bottom Line Returns from Small-scale Forestry*, 17–22 June 2007, Sabin Resort Hotel, Ormoc City, Leyte.

suitable for smallholders. Plantation silviculture is defined to site-species selection, choice of seeds provenance, site preparation, initial spacing, weed control, fertilization, pruning and thinning. Most of the capital expense and labour requirement is required in the first year of plantation life (Baynes 2005). The timber quality information is being used to identify 'higher-value' products obtained from tree farms. Timber yield data are also being used to identify management strategies that increase returns to smallholders tree farmers.

This paper outlines the field procedures used to collect biophysical data from smallholder tree farms on Leyte Island. In the following sections, the objectives of the study are first stated along with the criteria for selecting tree farms in the study. The methods used to collect data are then outlined, followed by a brief outline and discussion of results.

RESEARCH OBJECTIVES

The main objective of this study is to determine the yield and quality of timber on smallholder tree farms on Leyte Island. Specifically, this study has aimed to:

1. Develop volume and yield tables for smallholder tree farms on Leyte Island;
2. Determine the quality of timber that can be obtained from smallholder tree farms; and
3. Develop a tree farm system model common to tree farms on Leyte Island.

Selecting Tree Farms to be Sampled

The areas in Leyte suitable for smallholder forestry were identified using a geographical information system (GIS). A two-stage, probability proportional to size (PPS) sampling framework was used to select municipalities and then barangays from which tree farms were selected (as described in Herbohn *et al*. 2005). The seven municipalities selected were Anahawan and Libagon in Southern Leyte Province, and Bato, Hindang, Isabel, Leyte and Dulag in Leyte Province. In addition to the sample tree farms, rainforestation farms established with the assistance of the Institute of Tropical Ecology of Leyte State University, were measured as sub-samples for tree farms planted to indigenous species.

Focus group discussions (FGDs) were then conducted in the seven municipalities to be sampled, to which barangay captains or their representative, local government unit (LGU) officials and other stakeholders were invited. At these FGDs, a list of all tree farms in a municipality or barangay within their jurisdiction was compiled in consultation with barangay captains and municipal officials, particularly those from the Municipal Agricultural Office (MAO) and Department of Environment and Natural Resources (DENR). The tree farms identified through this process formed the tentative list of tree farms on which plots were to be established. Included also in the tree measurement activities is a small number of tree farms from Baybay, Albuera, Ormoc, Matalom, Mahaplag, Abuyog and Jaro in the province of Leyte and from Maasin and Macrohon from Southern Leyte Province that were identified as part of other project activities, namely the trialling of bus tours as a means of providing extension advice (Baynes 2007).

A tree farm qualified for inclusion in the sample if it had an area of 0.1 ha or greater and contained 100 trees or more. Often tree farms had several distinct 'blocks' of trees (e.g. different species or ages) and within each block two circular plots were established. Each block was required to be able to accommodate two non-overlapping circular plots. In order to assess potentially significant edge effects, one plot was located in the plot centroid and the other on the edge. Each plot was required to have at least seven trees with dbh of at least 10 cm within the five metres radius. If this was not the case then the plot radius was extended to 10 m to accommodate seven trees. The farm also needed to be accessible, and a maximum of an hour normal walking was set as the upper limit for the accessibility criteria.

Gaining Access to Tree farms

All tree farms were located on private land and to gain access it was necessary to consult with the owners and various elected officials at the municipality and barangay level. A courtesy visit was made to the municipal mayor and barangay captain, at which time a letter from the country project leader was presented.

Each tree farmer was visited at their house, their permission was asked and the purpose and importance of the study was personally and thoroughly explained to them. A letter from the country project leader was also handed over to support their explanation. As soon as the owner understood the project and approved the activities to be undertaken, a farm boundary and tree survey was undertaken using a hand-held GPS (Garmin 76) receiver. Subject to the tree farms meeting selection criteria, blocks and plots were then delineated and tree measurements done. Additional tree farms within a barangay were sometimes identified during field visits.

Data Collection Methods

Two field teams were established. The first team (referred to as the survey team) comprised of two people (one of whom was an experienced surveyor and proficient in the use of GPS and Mapsource), who were responsible for the survey of the perimeters of the tree farm and blocks within the tree farm. A second team (referred to as the tree measurement team) consisted of three enumerators, who established the plots and collected site and tree data.

In most instances the survey team surveyed the tree farms accompanied by a guide (a tenant, owner or owner's relative) ahead of the tree measurement team and identified those tree farms which qualified for inclusion. This facilitated in preparing the itinerary of the tree measurement team. The typical smallholder farm has a combination of various agricultural activities including coconuts, small crops, tree farms (tree blocks or plantations) and rice. A photo of the whole farm was taken featuring the farming activities and landscapes of the farm. As part of the survey, a sketch map of the farm was prepared which recorded the location of the farming activities and outlining the features of the tree blocks. GPS information was downloaded to a computer, through which a sketch map could easily be generated. Trees within the tree farms were blocked according to the homogeneity of its attributes. Tree blocks were determined based on the following criteria: species, age, size and form, topography, aspect, slope and natural divide. In every block at least two plots were established – the centroid and edge plots. Where the block was large and heterogenous, one or two additional plots were established, usually at the opposite side of the established edge plot situated more or less between the centroid and the boundaries.

Red ribbon tied around the tree at the plot centre for easy locating by the tree measurement team

PVC pipe used to mark the plot centre

The waypoint of each plot was recorded and was marked with a ribbon tied to a tree at the plot centre for easy locating by the tree measurement team. The plot centre was marked with a 12.5 mm diameter and 30 cm long PVC pipe driven in the soil leaving about 50 to 75 mm above ground. Also, each plot was photo documented with respect to ground and canopy cover from two directions, due north and due south, four photos being taken for each plot.

All trees with a dbh greater than 5 cm were numbered using red or orange spray paint. Numbering started at the tree closest to due north at the periphery and proceeded in a clockwise manner until the reference point was reached. Numbering was particularly useful for avoiding duplication of measurement of a single tree within the plot and facilitating rapid data collection.

Data recording sheets were developed for recording information about the farm, the block, the plot, and log size and quality. The name and contact details of the farm owner, along with a unique farm code, were recorded on each farm data sheet. The farm code comprised the first three letters of the municipality name, followed by the first two letters of the name of the barangay where the tree farm was located, then a three digit number preceded by a letter ***F*** for tree farm and ***IT*** for rainforestation farms. For example, the third tree farm measured in Barangay Tigbao in the municipality of Libagon would be coded as ***LibTi F003.*** Block 1 in this barangay would be coded as ***LibTi F003B01.*** Block 1 and the plot 2 for tree number 8 would be coded as ***LibTi F003B01P02T08.*** A sketch of the farm and the various blocks was also recorded on the farm sheet, along with the GPS waypoints for the farm boundaries.

A separate data sheet was used to record information about each block, including a sketch and GPS waypoints. In addition, information about biophysical properties and species was recorded. Plot sheets were used to record details about edaphic characteristics of the plot, along with groundcover abundance, and stem tally of trees, bamboo, palms and cycads with a dbh of not less than 2.5 cm. In addition, all trees with a dbh of 5 cm and above were measured and recorded in the individual tree data sheet. From the centre point of the plot, distance and direction of each tree were recorded. Total height of every palm was recorded, but for trees, only the tallest specimen was measured. Using a bark thickness gauge, the bark thickness was recorded at 10 cm below breast height at the two opposite sides aligned to the centre of the plot. The bend or lean of trees was also noted. The length of the trunk up to the first branch was measured, and crown depth and radii from four cardinal directions were also recorded. The radii were taken from the crown edge with reference from four cardinal directions, siting the hypsometer to the base of the tree and reading the horizontal distance. Trees of the plot edge were also recorded. Aluminium coded tags were attached to the base of each measured tree using concrete nails, with the tag always facing to the centre of the plot.

Details of the logs expected to be produced from each tree with a dbh of 10 cm or more were recorded on the log data sheet. Trees considered for log sectioning were sketched (stick drawing only) taking note of their worst form, viewed from any side. The stem was divided into sections based on its general form and straightness. In every section of the tree, large and small end diameters (LED and SED) and length were recorded. In most cases the SED of the lower section of the tree became the LED of the next upper section. A third diameter was recorded when forking was present. Sectioning took place up to the stem or branch with LED of 10 cm. Four log grades were recorded: A = at least 70% timber recovery of the log section total volume with minimum length of 1.2 m, B = at least 50% timber recovery of the log section total volume, with minimum length of 1 m, C = at least 30% timber recovery of the log section total volume, with 0.5 m minimum length, and D = at least 10% timber recovery of the log section total volume, with no minimum length. For forking a grade of D was automatic.

Data were encoded and entered into Access, a relational database manager. The original data sheets were photocopied in triplicate. The original forms are held in the ACIAR project office at LSU, with copies being held by other designated members of the research team. The materials, equipment and instruments used in this study as well as a short description of its utility are presented in Table 1.

Table 1. Material, equipment and instruments and its corresponding functions

Material, instruments and equipment used	Functions
GPS receiver	Mainly for referencing farms and mapping of the tree farm
Laser Ace Hypsometer	To collect data for diameter (large end and small end), log-sections and branches, height, crown radius and distance of each tree with reference to the plot centre
Compass	To obtain bearings of each sample tree in the plot with reference to the plot centre
Diameter tape	Mainly used to collect dbh data and diameter at the tree base
Bark thickness gauge	To obtain data on the thickness of bark at least one foot below breast height of the tree
Digital camera	Mainly used for photo documentation
Aluminium tags, set of letter and number punches, hammer and concrete nails	Made from aluminium sheet gauge 28 and cut into about 2cm by 5 cm lengths. Letter and number punches were used to engrave farm codes, which were attached to each tree with diameter 5cm and above. The tag was driven into the base or buttress of the tree with a concrete nail
Spray paint	Mainly used for assigning tree numbers for data collection purposes. Colours are mainly orange and red, and sprayed above breast height facing always to the reference point to avoid duplication of tress to be sampled and for easy and facilitates faster during measurement
Data sheets and miscellaneous materials	Data sheets carefully designed to capture inventory data are equally important to data collection instruments. Data sheets were printed on substance 20 book paper (8.5 by 11 inch) using a photocopier. Mongol #2 pencils were used for writing

Some Results and Discussions

The assessment of timber quality and yield has been completed. Data have been collected on 5664 trees from 532 plots established on 119 tree farms and socio-economic data have been collected from each of the tree farmers. Data on 10,565 log sections have also been collected. All data have now been entered into an ACCESS database (Figure 1). On average, the merchantable volume is only 37.4% of the gross volume (Table 2). The data indicate that improved silviculture could considerably improve the yield of merchantable timber and hence the financial returns to smallholders. Some results from the analysis of the tree farm data are presented in Vanclay *et al.* (2007). The tree farm data are also being linked with other data sets including socio-economic data collected from interviews with the tree farm owners and biodiversity data (see Herbohn *et al.* 2007 for further discussion).

Data collected from the tree farms are currently being analysed and used to develop yield tables and growth models for the key species grown by smallholders, including *Gmelina arborea, Swietenia mahogani* and *Acacia mangium*. Figure 2 provides estimates of the gross and merchantable volumes of timber from tree farms in Leyte based on data collected as part of the current study. Notably, there is a large difference between municipalities in the volume of timber currently in smallholder tree farms. Further, there is a large difference between the gross volume of timber and the merchantable volume. This result confirms field observations that poor silviculture by smallholders has meant that they have failed to capture anywhere near the full potential of their sites.

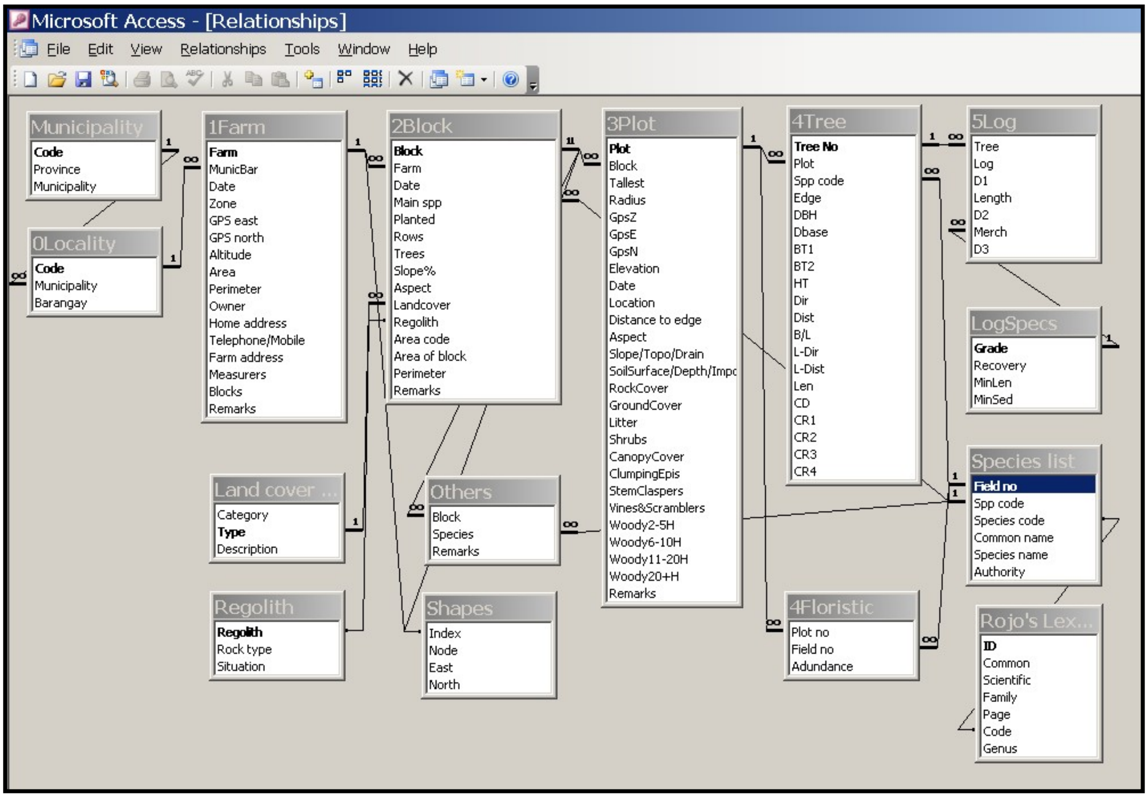

Figure 1. Screenshot of ACCESS database illustrating key site, plot, tree and log data collected from smallholder tree farms.

Table 2. Tree volume (gross and merchantable) per sampling municipalities

Municipality	Municipality code	Gross volume (m^3)	Merchantable volume (m^3)	Merchantable timber to gross volume (m^3)
1. Isabel	Isa	5958	2364	39.7
2. Leyte	Ley	4396	1610	36.6
3. Hindang	Hin	812	382	47.0
4. Bato	Bat	16031	5315	33.2
5. Libagon	Lib	5960	2415	40.5
6. Anahawan	Ana	2332	1038	44.5
7. Dulag	Dul	468	235	50.2
8. Albuera	Alb	49.83	20.06	40.3
9. Baybay	Bay	771.94	275.34	35.7
10. Matalom	Mtl	481.27	150.29	31.2
11. Maasin	Maa	284.22	90.81	32.0
12. Macrohon	Mch	130.04	59.48	45.7
13. Mahaplag	Mah	2998	1286.24	42.9
14. Abuyog	Abu	342.71	113.35	33.1
15. Jaro	Jar	22.87	11.48	50.2
Total		41,037.91	15,366.05	37.4

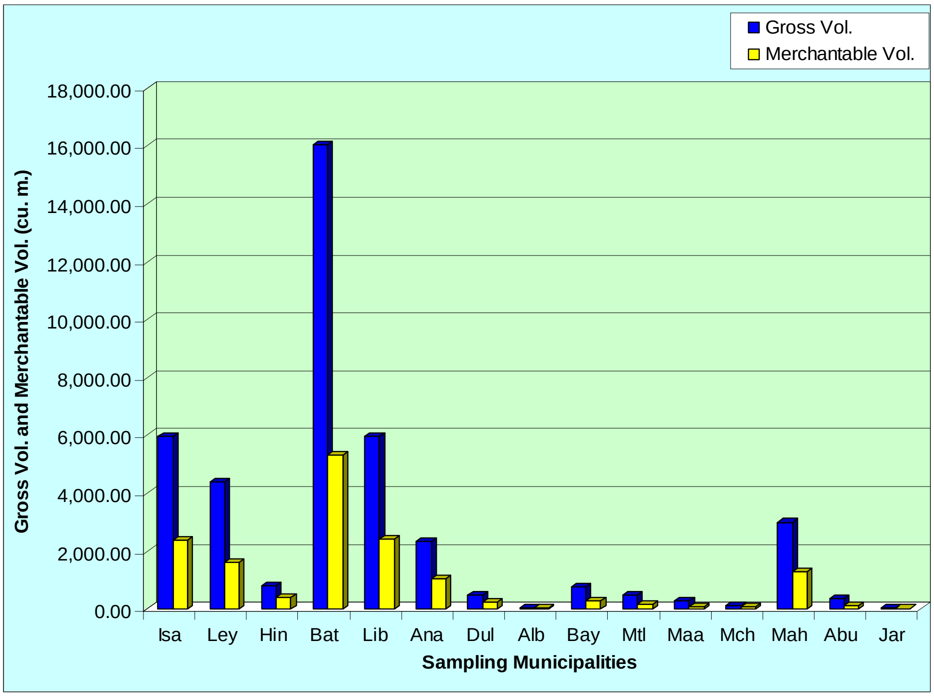

Figure 2. Gross and merchantable volumes of timber from tree farms in Leyte Province

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